Comparison Analysis of TCP Weswood+ and New Reno on Wireless Mesh Network Using NS-3

Dimas Zubaleta Guardiola Heriyanto [1] , Nugroho Suharto [2*] , Mila Kusumawardani [3]

[1,3] Digital Telecommunication Network Study Program, Department of Electrical Engineering, State Polytechnic of Malang, 65141, Indonesia.
[2] Telecommunication Engineering Study Program, Department of Electrical Engineering, State Polytechnic of Malang, 65141, Indonesia.

[1] guardioladimas07@gmail.com ,[2] nugroho.suharto@polinema.ac.id, [3] mila.kusumawardani@polinema.ac.id

***Abstract*— The demand for internet connectivity continues to increase as most daily activities are now inseparable from network access, leading to the development of large-scale wireless infrastructures such as Wireless Mesh Networks (WMNs). As the number of home internet users grows, network traffic also increases, potentially causing congestion. TCP New Reno and TCP Westwood+ are two TCP variants designed to improve Quality of Service (QoS) in large wireless networks. This study evaluates the performance of both variants using a wireless mesh network modeled and simulated in NS-3. In Scenario 1, the WMN topology was successfully implemented, and both TCP variants were tested and compared. The results show that TCP Westwood+ achieved the highest average throughput, packet loss, and delay values, namely 1.82447 Mbit/s, 0.0391527%, and 160.899 ms, respectively. However, TCP New Reno demonstrated better jitter performance with the lowest value of 2.310563 ms on a 40-node network. In Scenario 2, two nodes requested FTP services using TCP and UDP. TCP New Reno showed better performance in packet loss, delay, and jitter, while TCP Westwood+ achieved the highest average throughput of 1.9983 Mbit/s on 40 nodes.**

***Keywords*— Congestion, NS-3, TCP New Reno, TCP Westwood+, Wireless Mesh Network, QoS.**

I. INTRODUCTION

At present, various human activities cannot be separated from the internet network. Starting from downloading or uploading data, sending e-mails, streaming for work and study activities and so on. As a result of communication and information exchange today, users are very demanding on delivery speed, security, and also guarantees that the information reaches the recipient intact [1]. According to data from the Indonesian Internet Service Providers Association (APJII), as of February 2024, Indonesia's internet penetration rate touched 79.5%. Compared to the previous period, there was an increase of 1.4%. As of 2018, Indonesia's internet penetration reached 64.8%. Then sequentially, 73.7% in 2020, 77.01% in 2022, and 78.19% in 2023 [2]. At present, human activities are kept secret from the Internet. As a result of the current communication and exchange of information [2], users demand very much the speed of shipping, security, and also the guarantee that information reaches the receiver intact [3]. On the other hand, when the development of Internet users in each home or offices increases, the amount of network traffic increases. The increase in the number of users in a access point leads to a compact or congestion of the network [4]. The research and development found an alternative network of wireless mesh network [5] which is the best wireless technology, may support applications. In [4] emitting substantial data deliveries, TCP algorithms have been developed to address frequent problems in the network of congestion or a slowing of the progress of data packets caused when a network is overloaded or overloaded [6]. There are several ways to prevent contamination, but they are not more effective than using the algorithm-control protocol (TCP) algorithm [7]. So on this new research titled "Tcp Westwood+ And New Reno Comparisons Analysis On The Wireless Mesh Network Using The Ns-3" to reduce the ns-3 connection in the network using TCP Westwood+ and new Reno types algorithms. The two TCP algorithms have significant differences in overcoming congestion, namely in the congestion control mechanism or in how to prevent excessive transfer-rate cuts when congestion occurs [8].The research methods to be used can be simulated with ns-3 software. Before conducting research on the influence of the number of users on the throughtput parameters and packet loss need to be run by a scenario design to be used in future simulations and other parameters.

II. METHOD

A. Research stages

The first stage involves conducting a comprehensive literature study to identify relevant theories, methods, and related works. Next, research scenarios and simulation parameters are carefully designed according to the study objectives. After the scenarios are defined, the simulation process is executed using the NS-3 network simulator. The data obtained from the simulation results are then systematically compared with other TCP variants to evaluate performance differences. These comparisons focus on key Quality of Service (QoS) parameters such as throughput, delay, packet loss, and jitter. Finally, all analyzed results are synthesized to draw conclusions and provide a clear and comprehensive

*Corresponding author

understanding of the overall network performance and the effectiveness of each TCP variant.

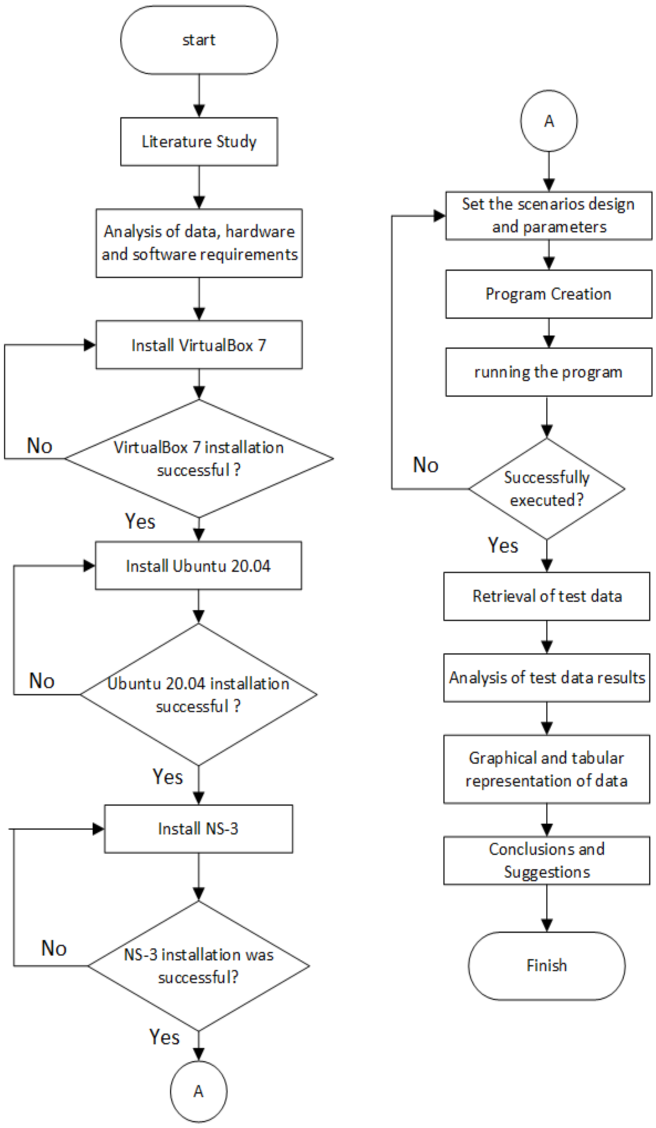


Figure 1. Research stages

Fig. 1 shows a diagram of the stage of research that will be done with the following explanation:

1) The first stage is a literature study on the theory of TCP, network topology and parameters measured during simulation.
2) The second stage analyzes the data, parameters, software, and hardware requirements needed in this research.
3) The third stage installs the virtual box v7 which is used to run the Linux OS. if successful go to the next stage
4) The fourth stage installs the Linux OS, namely ubuntu 20.04 LTS on the previously installed virtual box. if successful go to the next stage
5) The fifth stage after installing ubuntu 20.04 is to install network simulator 3 which will be used for network simulators. if successful go to the next stage
6) The sixth stage designs scenarios and parameters as in subchapter 3.5 simulation scenarios.
7) The seventh stage of making a simulation program / coding according to the predetermined scenario.
8) The eighth stage runs the simulation program/coding on NS-3 in accordance with the predetermined scenario.
9) The ninth stage gets the results of the simulation that has been run using the scenario that has been designed. If the test results are successful in the simulation, then proceed to the next process, namely retrieval of test data. But if the test results are considered a failure, then retesting the simulation process is carried out until the test results are successful and appropriate.
10) The tenth stage takes or collects test data results.
11) The eleventh stage analyzes the Westwood + and New Reno TCP algorithms from the simulation results. Each type of TCP comparison is sought which is better then compared between TCP types later according to the scenario.
12) The twelfth stage creates graphs and tables to represent the test result data.
13) The thirteenth stage makes conclusions from the results of research analysis and suggestions for further testing. Tools and Materials

TABEL I
HARDWARE

No	Nama Alat	Keterangan
1	Laptop Acer Swift 3	As the hardware to be used for simulations and report making

TABEL II
SOFTWARE

No	Nama Alat	Keterangan
1	Oracle VM VirtualBox 7	As the vitual machine running the OS ubuntu
2	Ubuntu 20.04 LTS	As an operating system used to install ns-3 software
3	Software NS-3	As the software which will be used for simulations during data testing
4	Software NetAnim	As software that displays tissue animation
5	Software VSCode	Software that will be used to authenticate a C++ language

B. System planning

The system block diagram refers to the formula of the problem, which is how the design diagram of the system solves the problem raised in research. Here is the topology diagram block to be used, as shown in Fig. 2.

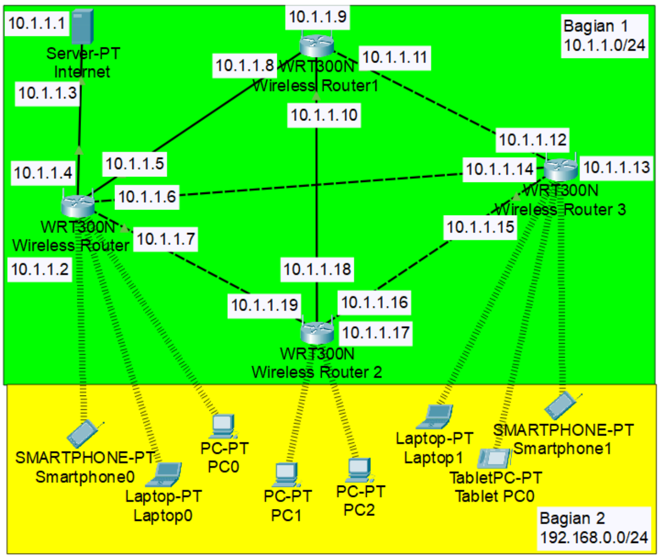


Figure 2. Block diagram topologi

The topology diagram block is divided into two sections, in which the first section represents a gateway and access point with an IP address distinguished by the second and connected by an LAN wire. On the second part is the noggin client. The second part is the user that requests the desired data to the first and differentiated also in the use of IP addresses and wirelessly access points.

C. *Simulation flow diagram*

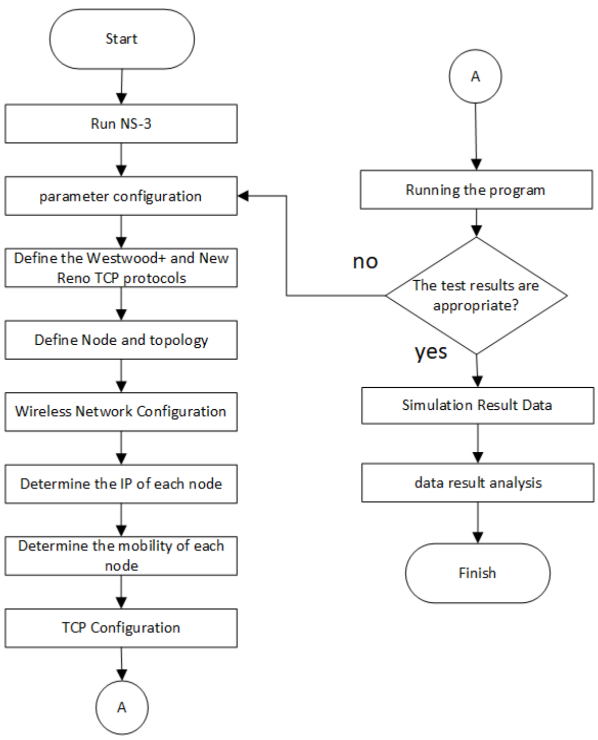


Figure 3. Simulation flow diagram

In Fig. 3 is a diagram of the flow of simulation with the following explanation:

1. The first stage is running ns-3 software on 20.04 LTS
2. The second stage conficates the parameters to be used for the simulation in table 3.
3. The third stage determines a variability of TCP protocol between TCP New Reno or TCP Westwood.
4. The fourth stage makes the nodes and topology to be used in the simulation.
5. The fifth stage of the network type to be used on this research is a wireless network with ieee stands. 802.11n by 5 Ghz frequency.
6. The sixth stage identifies the IP address of a gateway, access point and user
7. The seventh stage determines each node of mobility.
8. The eighth stage is implementing a protocol transpot, that is, a transaction control protocol (TCP).
9. The ninth stage runs a program on an ns-3 software that has designed the scenario.
10. The tenth stage, whether the simulations are done has been successful. If the test results are successful then proceed to the next process of getting data from the simulation. But if the test results were deemed to be a failure then a reexamination was performed to phase two.
11. The eleventh stage gets the results of simulations already run using a preconceived scenario.
12. The twelfth stage of the simulation data analysis.

D. *Simulation scenario*

The scenario used will be equated to Table 3 simulation parameters, no parameters other than TCP variance on a wireless network so that the result can be compared to the TCP variance algorithm TCP Westwood+ and TCP New Reno. The scenario 1 is shown in Fig. 4.

1) Scenario 1

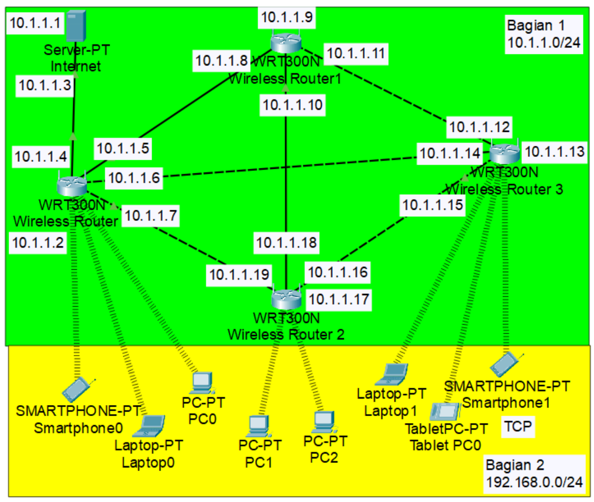


Figure 4. Block diagram of scenario 1

In simulation process using the TCP Westwood + and TCP New Reno protocols by designing simulation parameters that have been determined in Table 3, the application of ip addresses on each node and the delivery protocol, namely TCP. Simulation 1 will test with an initial experiment of 5 nodes then increase to 50 nodes with 1 client requesting a request to the source. Furthermore, observation and analysis of simulation result data in the form of xml and flowmonitor.

2) Scenario 2

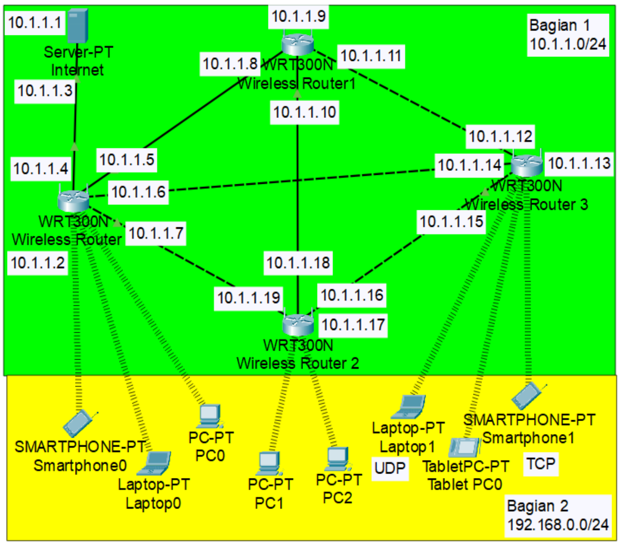


Figure 5. Block diagram of scenario 2

In the same way that scenario 2, pictured in Fig. 5, simulates scenario 1. With a difference of 2 clients requesting a request from 1 source. On client 1 of thequest using TCP protocol while client 2 use UDP.

E. Testing parameters

In this study there are several parameters to be applied to programming as follows Tabel 3 :

TABEL III
SIMULATION PARAMETERS

Parameter	Nilai
Simulation Time	60s
Data rate wireless	30 Mbps
Bandwitdh bottleneck	5 Mbps
Delay bottleneck	1 ms
Packet size	1024 Mb
Wifi channel type	802.11n 5 GHz
Number of nodules	5,10, 20, 30, 40, dan 50

III. RESULT AND DISCUSSION

A. Design Result

At the beginning of access point and gateway/server were specified at coordinates x=0, y=0 and z=0 and x=0.2, y=0 and z=0 so access point and the gateway/server were adjacent as to a client specified at random or unregulated. There is 1 Access Point and Server each, while the number of clients is reduced by the number of access point and server nodes. Access point and gateway/server uses constant position mobility models that are intended to establish the place and remain stationary while the client also uses the random walk 2d mobility models, which the system can be used for the client at random every 1s. For IP address, access point and gateway/server uses a class 10.1.1.0/24 and 127.0.0.0/8 by default for loopback addressing. The clients using grade c which is 192.168.0.0/24. Here's the design of topology, as shown in Fig. 6 and Fig. 7 :

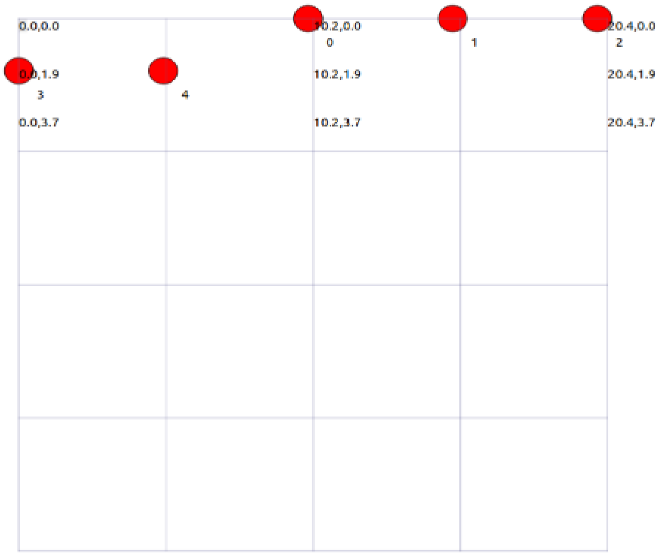


Figure 6. Design 5 nodes

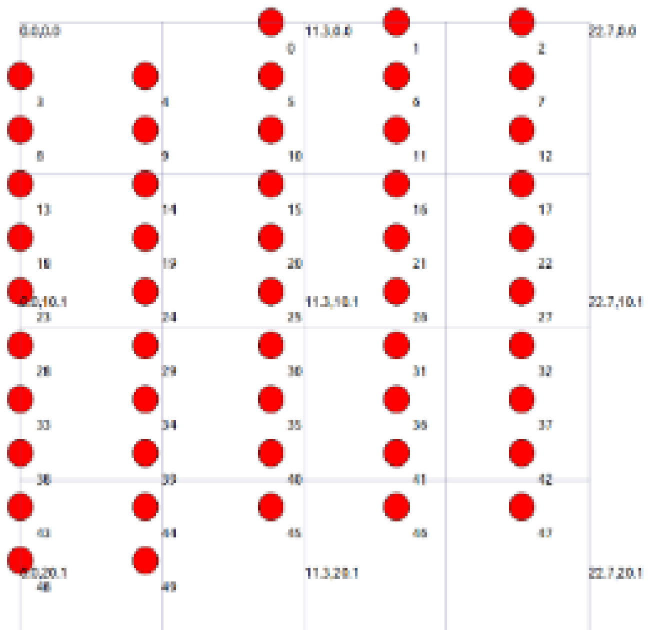


Figure 7. Design 50 nodes

B. Testing data

1) Scenario 1

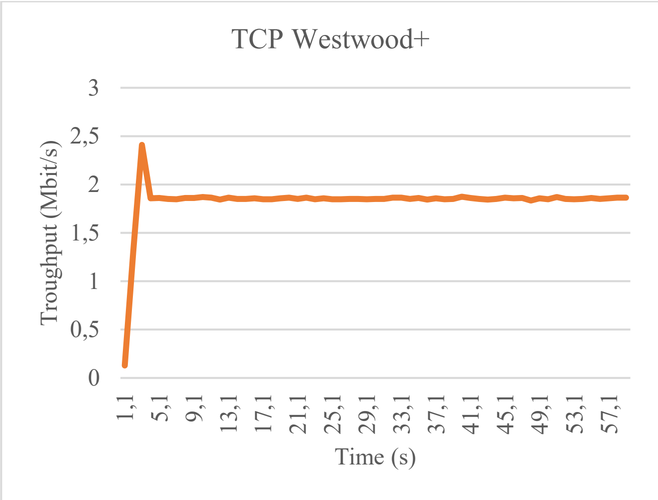


Figure 8. Real-time throughput graph of TCP Westwood+ with 50 nodes

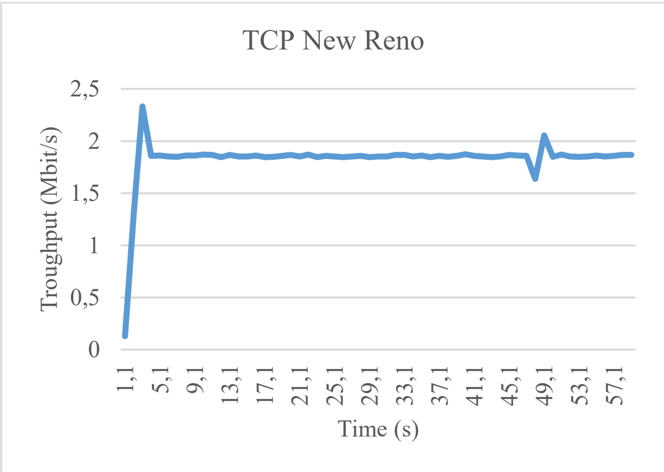


Figure 8. Real-time throughput graph of TCP New Reno with 50 nodes

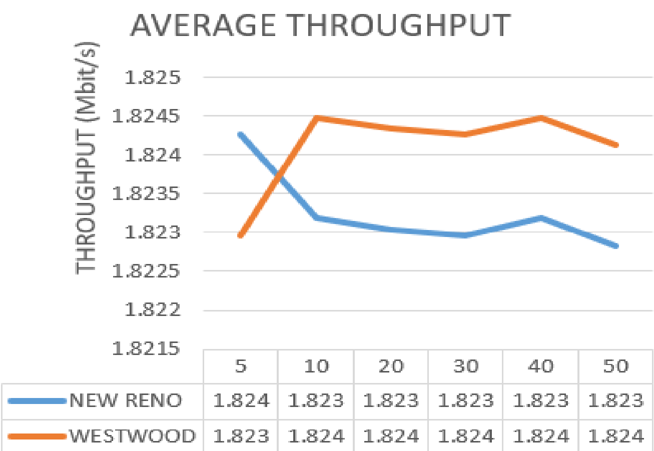


Figure 9. Comparison of average throughput to node scenario 1

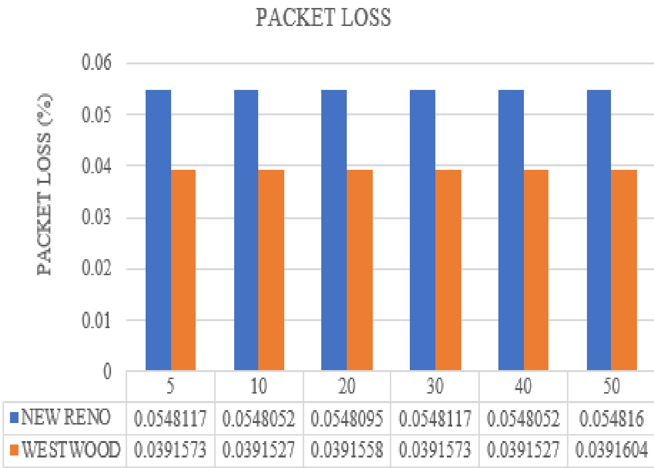


Figure 10. Comparison of packet loss to node scenario 1

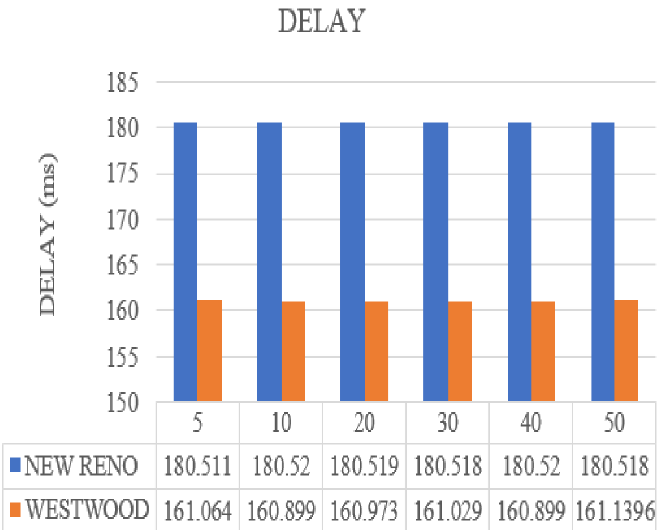


Figure 11. Comparison of delay to node scenario 1

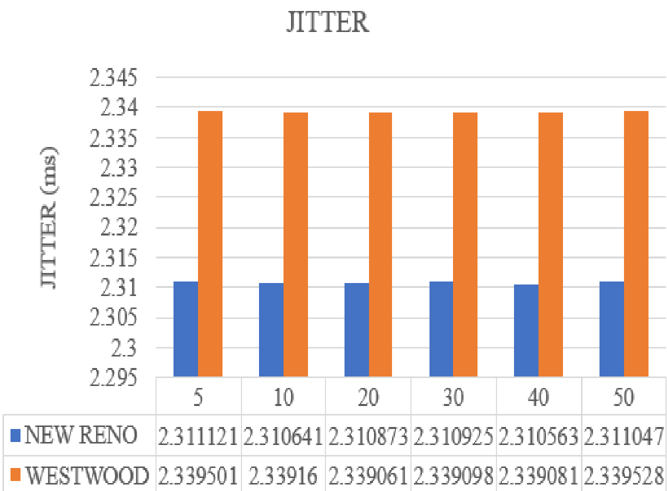


Figure 12. Comparison of jitter to node scenario 1

2) Scenario 1

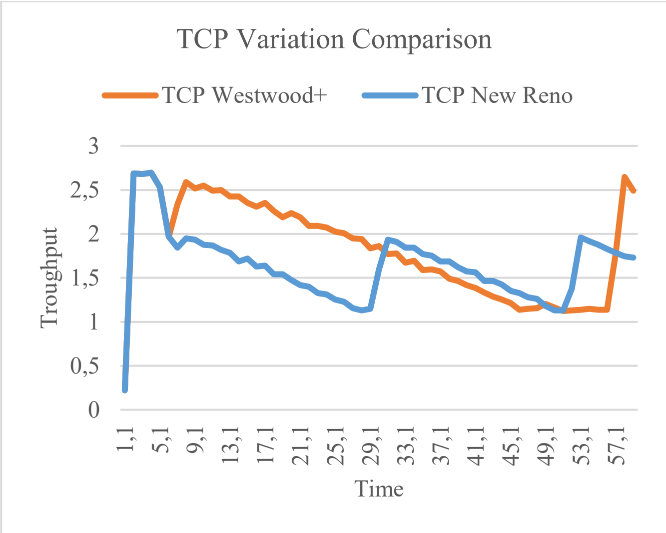
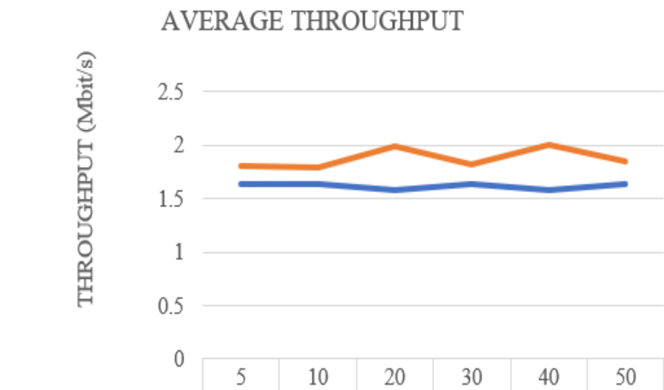
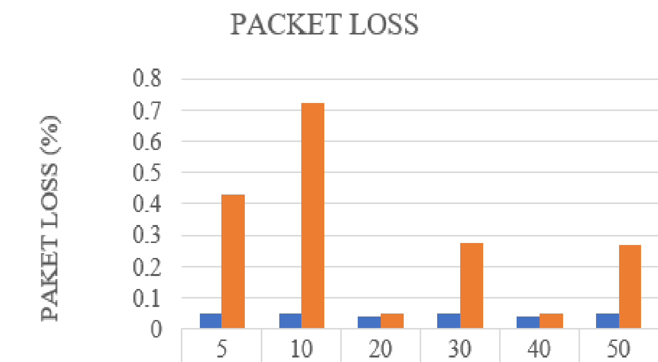


Figure 14. Real-time throughput graph of TCP New Reno and Westwood+ with 50 nodes



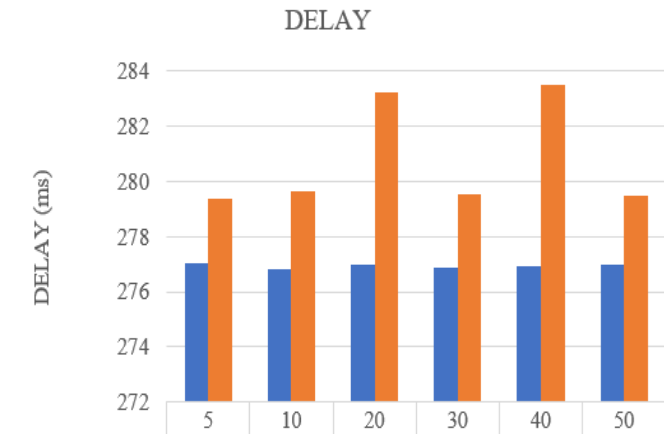
	5	10	20	30	40	50
NEW RENO	1.63622	1.63485	1.57177	1.63144	1.57355	1.63308
WESTWOOD+	1.80019	1.78586	1.9927	1.81507	1.9983	1.83938

Figure 13. Comparison of average throughput against scenario 2 node



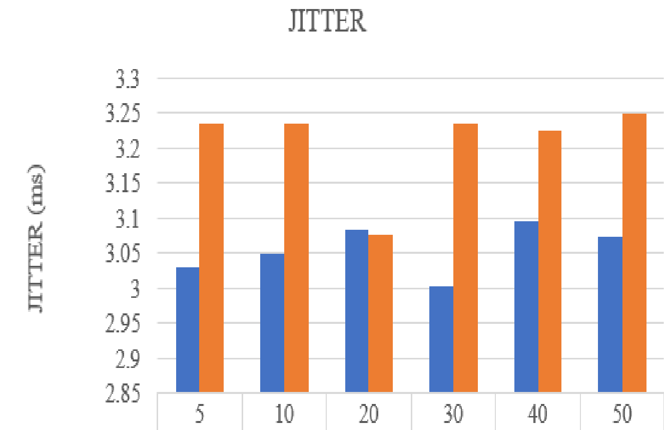
	5	10	20	30	40	50
NEW RENO	0.0516	0.0515	0.0387	0.0513	0.0388	0.0514
WESTWOOD+	0.4299	0.7222	0.048	0.2756	0.0484	0.2712

Figure 14. Comparison of packet loss to node scenario 2



	5	10	20	30	40	50
NEW RENO	277.004	276.791	276.9751	276.861	276.927	276.979
WESTWOOD+	279.357	279.634	283.228	279.525	283.478	279.485

Figure 15 Comparison of delay to node scenario 2



	5	10	20	30	40	50
NEW RENO	3.030251	3.049871	3.083031	3.00385	3.09668	3.075115
WESTWOOD+	3.234789	3.235329	3.076437	3.236268	3.225476	3.248711

Figure 16 Comparison of jitter to node scenario 2

C. *Analyzing data*

The tcp congestion control algorithm is the main factor that plays an important role in influencing the performance and the amount of data sent in the network [9]. In Fig. 8, Fig. 9, and Fig. 14 contained in scenario 1 and 2 can be seen with the handling of each tcp variation, all nodes start with a slow start phase then a congestion avoidance phase until the occurrence of packet loss each variant will perform a fast recovery phase and a retransmit phase to keep the connection stable. However, in scenario 1, TCP New Reno will experience packet loss again at the end of the simulation time caused by the mobility of the receiving node away from the access point so that it experiences packet loss again in contrast to TCP Westwood + which is constant until the simulation time ends because TCP New Reno implements AIMD so that if congestion occurs, sshthres and cwnd will be lowered and TCP New Reno is only able to handle one lost data packet segment so that it can handle the retransmission of more than one lost data packet in one window without lowering sshtresh multiple times because it will not leave the fast recovery phase before all packets in one window are acked. It will not leave the fast recovery phase before all packets in one window are acked all in contrast to TCP Westwood + which implements AIAD which is useful for preventing excessive transfer-rate cuts when congestion occurs because in the event of congestion lost packets will not be responded to or lowered to the extreme because the ssthres and cwnd values will be estimated adaptively based on the end-to-end bandwidth on the network. While in scenario 2, whereas if congestion occurs in TCP New Reno, the transfer rate will be reduced by half the value of sshtres and cwnd and when some packets are lost from the data sequence, TCP New Reno sends data without retransmission time out which causes less delay, jitter than it should be in order to detect packet loss more quickly and quickly to be sent back to the client with the fast retransmit phase. Unlike TCP Westwood+ which is useful to prevent excessive transfer rate cuts when congestion occurs, in the event of congestion the lost packets will not be lowered to the extreme because the ssthres and cwnd values will be estimated adaptively based on the estimated bandwidth on the network so that the speed is constant until the end of the simulation time.

Fig. 10 up until Fig. 13, show that for scenario 1, in the qos parameter average througput, TCP Westwood+ performance is very good at nodes 10,20,30,40 and 50 but at node number 5, TCP New Reno performance is better with a value of 1.82426 Mbit/s. On average throughput, the highest value is obtained on nodes numbering 40, namely 1.82447 Mbit/s then on packet loss and delay parameters, TCP Westwood + performance is better in all nodes compared to TCP New Reno while inversely proportional to the jitter parameter, TCP New Reno is better at handling it.

In Fig. 15- Fig. 18, similar to scenario 1 but there are two sources requesting data, one source requests TCP data and the other requests UDP data. FTP protocol requests are UDP to cause congestion. It was found that the best average throughput parameter in handling was TCP Westwood + in all nodes than TCP New Reno with the highest value of 1.9983 Mbit / s at node 40. then in other QOS parameters such as packet loss, jitter and delay performance that can handle better is TCP New Reno in all nodes.

IV. CONCLUSION

Designing a wireless mesh network on Network Simulator 3 as a wide wireless network can be done by implementing TCP variants New Reno and Westwood + in the network so that it can reduce excessive congestion on the network. The implementation can be seen in scenarios 1 and 2 with the number of nodes namely 5, 10, 20, 30, 40 and 50 given an FTP protocol namely TCP and UDP to provide random and or excessive congestion. In scenario 1, there is 1 node that requests the FTP protocol, namely TCP. The highest value results are obtained from TCP Westwood + with average throughput, delay, and packet loss parameters, but testing other QoS parameters on jitter obtained the best handling on TCP New Reno. In scenario 2, there are 2 nodes that request the FTP protocol, namely TCP and UDP. The results of QoS testing with the average throughput parameter value obtained the highest value on all nodes by TCP Westwood + but in other packet loss, jitter, and delay parameters TCP New Reno can handle it well.The addition of the number of nodes in a wireless mesh network results in different QoS parameter values for each TCP variant. In scenario 1, it can be seen that TCP Westwood+ performance is very good on nodes 10,20,30,40 and 50 on QoS parameters such as average throughput, packet loss, and delay request of FTP data via TCP protocol while on node 5 the best average throughput results are obtained on the TCP New Reno variant and jitter parameters on all nodes. Scenario 2 adds the FTP protocol, namely UDP, to have an impact on excessive congestion or congestion so that the QoS values on both variants can vary. It can be seen that the best average throughput parameters are obtained on the TCP Westwood+ variant with values above TCP New Reno on all nodes, but other parameters such as packet loss, jitter, and delay on the TCP protocol get the best values on the TCP New Reno variant while for the packet loss and jitter parameters on the UDP protocol the handling is better on TCP Westwood+.

REFERENCES

[1] R. K. Jha and K. P. Jha, “A comparative performance analysis of routing protocols in MANET using NS3 simulator,” *International Journal of Computer Network and Information Security*, vol. 7, no. 4, pp. 62–68, 2015.

[2] M. Arif, “APJII jumlah pengguna internet Indonesia tembus dua ratus dua puluh satu juta orang,” *apjii.or.id*, Feb. 7, 2024. [Online]. Available: https://apjii.or.id/berita/d/apjii-jumlah-pengguna-internet-indonesia-tembus-221-juta-orang. Accessed: May 4, 2024.

[3] S. G. Salman, J. G. A., and W. R. D., “Analisis unjuk kerja TCP window size enam puluh empat kilobyte menggunakan algoritma TCP New Reno pada jaringan wired dan wireless,” *RESISTOR Elektronika Kendali Telekomunikasi Tenaga Listrik Komputer*, vol. 4, no. 1, pp. 55–68, 2021.

[4] P. R. Utami, “Analisis perbandingan quality of service jaringan internet berbasis wireless pada layanan internet service provider Indihome dan First Media,” *Jurnal Ilmiah Teknologi dan Rekayasa*, p. 25, 2020.

[5] M. R. G. Asgar, “Analisis perbandingan unjuk kerja algoritme TCP New Reno dengan TCP Westwood Plus untuk mereduksi kongesti pada jaringan WLAN,” 2018.

[6] T. Y. A. Nasron and R. M. R. Nasron, “Analisa kinerja TCP Hybla pada jaringan wireless mesh network,” *Jurnal Nasional Komputasi dan Teknologi Informasi*, vol. 2, no. 1, pp. 66–72, Jun. 2019.

[7] T. C. Alam and M. J. Alam, “Performance evaluation of TCP Vegas over TCP Reno and TCP New Reno over TCP

Reno," *JOIV International Journal on Informatics Visualization*, vol. 3, no. 3, pp. 275–282, 2019.

[8] Putra, "Analisis perbandingan unjuk kerja TCP New Reno dan TCP Westwood Plus pada jaringan kabel," Yogyakarta, 2019.

[9] Fakhroni, "Implementasi algoritme TCP Westwood Plus untuk mengurangi dampak kongesti pada jaringan LTE," 2018.

[10] H. Setiawan, "Analisis kinerja TCP New Reno dan TCP Cubic terhadap fase slow start pada jaringan mobile ad hoc menggunakan protokol AODV," 2021.

[11] H. Sutadi, "Pandemi dan meningkatnya kebutuhan akses data internet," *detik.com*, Feb. 24, 2021. [Online]. Available: https://news.detik.com/adv-nhl-detikcom/d-5435334/pandemi-dan-meningkatnya-kebutuhan-akses-data-internet. Accessed: Jul. 13, 2022.

[12] Iskandar and H. Akbar, "Analisa quality of service jaringan internet kampus studi kasus UIN Suska Riau," *Jurnal CoreIT Jurnal Hasil Penelitian Ilmu Komputer dan Teknologi Informasi*, vol. 1, no. 2, pp. 67–76, 2015.

[13] W. Y. Pamungkas and H. N. G. W., "Analisis perbandingan kinerja TCP Vegas dan TCP New Reno menggunakan antrian random early detection dan drop tail," *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer*, vol. 2, no. 10, pp. 3239–3248, 2018.

[14] M. Simanjuntak and A. S. D., "Analisis perbandingan quality of service jaringan internet berbasis wireless pada layanan internet service provider Indihome dan First Media," *Jurnal Ilmiah Teknologi dan Rekayasa*, vol. 10, no. 3, 2023.

[15] M. Polese, F. Chiariotti, E. Bonetto, F. Rigotto, A. Zanella, and M. Zorzi, "A survey on recent advances in transport layer protocols," *IEEE Communications Surveys and Tutorials*, vol. 23, no. 1, pp. 358–401, 2021.